Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 1997		**00-00-1997 to 00-00-1997**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Arctic Mixing and Tides	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Oregon State University,College of Oceanic and Atmospheric Sciences,104 Ocean Admin. Bldg.,Corvallis,OR,97331**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**2**	

ARCTIC MIXING AND TIDES

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Award No. N00014-95-1-0479

LONG TERM GOALS

The long-range goal of this research is to improve the description of the upper Arctic Ocean circulation and hydrographic fields, and the physical processes that determine these fields.

OBJECTIVES

The work consists of two distinct topics: (1) defining upper ocean Arctic variability by the collection and analysis of temperature and salinity data from a US Navy submarine and comparison of these data to other recent observations and climatic values; and (2) improving our understanding of the role of tide-related processes in setting the mixing rates in the pycnocline. The specific objectives of the present work are: (1) to investigate recent temporal variability in the large-scale circulation and distribution of water masses in the halocline and the Atlantic layer, and (2) to investigate the mechanisms and rates of mixing in the halocline and Atlantic Layer, since these govern the rate at which the oceanic heat from the subsurface core of warm Atlantic Water is mixed upwards towards the surface ice cover.

APPROACH

Hydrographic profiles were collected underway during SCICEX'95 using expendable (XCTD) probes, which were calibrated with CTD profiles at occasional surface stations. Temperature and salinity time series were also collected underway at the cruising depth of the submarine. The distribution and characteristics of the water masses determined from both profiles and time series were compared to observations obtained during SCICEX'93 and climatic values from the 1997 US-Russian Environmental Working Group (EWG) Atlas.

Tidal influence on mixing rates has been addressed by using results from the Kowalik and Proshutinsky [1994] barotropic Arctic tides model, combined with baroclinic tide generation models [Baines, 1982; Sjoberg and Stigebrandt, 1992], to estimate energy flux into the baroclinic field (and, ultimately, to mixing) as a function of geographic location.

ACCOMPLISHMENTS

The planned analysis of SCICEX'95 data has been largely completed, and two manuscripts on scientific results have been written: one has been submitted for publication and a second is in preparation for submission in Fall, 1997. Student S. Howard's MS thesis work entitled "Internal Tides and Mixing in the Eastern Arctic Ocean" will be completed in Fall, 1997.

SCIENTIFIC/TECHNICAL RESULTS

Using data from the SCICEX'95 and SCICEX'93 cruises, and the EWG Atlas, we have documented changes in the distribution of water masses of Atlantic and Pacific origins in the Canadian Basin, and the location of the front between them. This analysis confirms the magnitude and extent of warming of the Atlantic Layer in the Canadian Basin observed earlier in the 1990's, and documents the disappearance of the cold halocline from the Eurasian Basin in the 1990's, which has resulted in the saltiest surface waters in the Eurasian Basin since at least the 1950's.

Our work on tides shows that the conversion of barotropic tidal energy to internal tides and waves, and ultimately to turbulence, occurs primarily along the upper continental slope of the eastern Arctic. Modeled diffusivities arising from this energy transfer to small scales indicate peak heat fluxes above the Atlantic core of order 100 W/m^2. The model is being tested with data collected over the Yermak Plateau during CEAREX. Our work on tides strongly supports the notion that pycnocline mixing rates in the Arctic are orders of magnitude higher over the upper slope in the eastern Arctic than in the adjacent deep basins. The geostrophic velocities that arise from such spatial variations in tide-induced mixing are a significant fraction of the alongslope transport, but are not included in most present generation general circulation models.

RELATED PROJECTS

Student S. Howard is being supported by an AASERT award to work on the present project. Similar work relating tides to mixing is being carried out by L. Padman in the Canadian Archipelago and the Weddell Sea, both projects funded by NSF-OPP. This work includes collaborations with Dr. W. Maslowski (Naval Postgraduate School, Monterey), who has run a simplified Arctic 3-D GCM with M2 tidal forcing. Analysis of data from the SCICEX cruises is being performed in collaboration with Dr. M. Steele of the Applied Physics Laboratory, University of Washington, under ONR-High Latitude grant N00014-95-1-0437. Analysis of XCTD errors was performed in collaboration with M. S. Moustafa of Science Applications International Corp.

PUBLICATIONS

Steele, M, and T. Boyd, Retreat of the Cold Halocline Layer in the Arctic Ocean, *J. Geophys. Res.*, submitted, October, 1997.

Howard, S., Internal Tides and Mixing in the Eastern Arctic Ocean, M.S. thesis, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR, 1997.